

# **EASY-TO-START STRUCTURE OF A D.C. BRUSHLESS MOTOR**

## **Background of the Invention**

### **1. Field of the Invention**

The present invention relates to an easy-to-start structure of a D.C. brushless motor in which the rotor of the motor may rest in an easy-to-start position when the rotor stops rotating.

### **2. Description of the Related Art**

Fig. 9 of the drawings, which corresponds to Fig. 2b of U.S. Patent No. 4,899,075 to Hasebe issued on Feb. 6, 1990, illustrates a conventional stator structure of a bi-directional brushless D.C. motor comprising a pair of stator cores each having a plurality of salient poles 9a~9d each of which is shaped to have a notched portion 92 in one of opposite corners, in a direction of rotation of the rotor, and oriented so as to be next to the unnotched corner of the stator pole adjacent thereto.

Fig. 10 of the drawings illustrates another conventional stator structure of a D.C. brushless motor structure disclosed in Taiwan Utility Model Application No. 81217854 published on Nov. 1, 1993 and entitled IMPROVED STATOR YOKE FOR A STATOR OF A HEAT-DISSIPATING FAN MOTOR. Each of an upper stator yoke 8 and a lower stator yoke 8 comprises plural poles 81 on a peripheral edge thereof, each pole 81 having a notched portion 82 in a side thereof.

The notched portions 92 and 82 in these conventional D.C. brushless motor structures are designed to create an uneven magnetic force associated with the permanent magnet, thereby preventing the rotor to stop in a dead corner for starting and thereby allowing the rotor to be restarted.

## **Summary of the Invention**

An object of the present invention is to provide an easy-to-start structure of a D.C. brushless motor that prevents the rotor of the motor to stop in a dead corner for starting and that allows the rotor to be restarted easily.

An easy-to-start structure for a D.C. brushless motor in accordance with the present invention comprises a base including a through-hole having an end in which a support section is provided. Plural windings and an IC control member are mounted to the base, the IC control member being located between two windings that are adjacent to each other. At least one magnetically attractive positioning member is mounted to the base and located between two windings that are adjacent to each other. A rotor comprises a shaft rotatably held by the support section and a permanent ring magnet mounted to the shaft, the permanent ring magnet having north and south poles, each of the south pole and the north pole having a strong magnetic area. The positioning member attracts and thus retains one of the strong magnetic areas of the permanent ring magnet in a position proximal to the positioning member when the rotor stops. Thus, the rotor rests in a predetermined position not located in a dead corner for restarting.

Other objects, specific advantages, and novel features of the invention will become more apparent from the following detailed description and preferable embodiments when taken in conjunction with the accompanying drawings.

## **Brief Description of the Drawings**

Fig. 1 is an exploded perspective view of a first embodiment of a D.C. brushless motor structure in accordance with the present invention.

Fig. 2 is a sectional view of the D.C. brushless motor structure in Fig. 1.

Fig. 3 is an exploded perspective view of a second embodiment of the D.C. brushless motor structure in accordance with the present invention.

Fig. 4 is a sectional view of the D.C. brushless motor structure in Fig. 3.

Fig. 5 is a sectional view taken along line 5-5 in Fig. 4.

Fig. 6 is an exploded perspective view of a third embodiment of the D.C. brushless motor structure in accordance with the present invention.

Fig. 7 is a sectional view of the D.C. brushless motor structure in Fig. 6.

Fig. 8 is a sectional view taken along line 8-8 in Fig. 7.

Fig. 9 is a plan view of a stator core of a conventional D.C. brushless motor structure disclosed in U.S. Patent No. 4,899,075.

Fig. 10 is a perspective view of another conventional D.C. brushless motor structure disclosed in Taiwan Utility Model Application No. 81217854.

#### **Detailed Description of the Preferred Embodiments**

Preferred embodiments in accordance with the present invention will now be described with reference to the accompanying drawings.

Referring to Fig. 1, a first embodiment of a D.C. brushless motor structure in accordance with the present invention generally comprises a base 1 and a rotor 2.

The base 1 is a casing having a through-hole 11. A support section 12 is provided in an end of the through-hole 11. The support section 12 may be a bearing or shaft sleeve for rotatably holding a shaft 21 of the rotor 2. Even-numbered windings 13 are securely mounted to an outer wall of the base 1 or an inner wall defining the through-hole 11. An IC control means 14 comprising a conventional drive circuit and a Hall element is mounted on the base 1. The IC control means 14 is located between two adjacent windings 13 and electrically connected to the windings 13. In order to allow stable rotation of the rotor 2, a support element 15 is mounted on the other end of the base 1. The support element 15 may be directly fixed on the base 1. As shown in

Fig. 1, the support element 15 comprises engaging pieces 151 that are respectively engaged in positioning holes 16 in the base 1. The support element 15 comprises a support section 152 in the form of a bearing or shaft sleeve. Of more importance, at least one positioning member 17 made of magnetically attractive metal is mounted to the base 1. The positioning member 17 can be of any shape, such as a cylinder, parallelepiped, or plate. As illustrated in Fig. 1, the positioning member 17 is positioned in a complimentary positioning hole or groove 18 in the base 1, the positioning groove 18 being located between two windings 13.

The shaft 21 of the rotor 2 is rotatably held by the support section 12 of the base 1 and the support section 152 of the support element 15. A permanent ring magnet 22 is mounted to the shaft 21 of the rotor 2 and comprises north and south poles. The permanent ring magnet 22 comprises at least two transition areas 221, each transition area 221 having a first end contiguous to a north pole and a second end contiguous to a south pole. Each of the north and south poles has a strong magnetic area 222 located in an intermediate position between two transition areas 221. In addition, the rotor 2 may have blades 23 provided thereon so as to drive air to flow when the rotor 2 turns, thereby forming a heat-dissipating fan.

As illustrated in Fig. 2, the base 1 has even-numbered windings 13 mounted to the outer wall thereof. The rotor 2 is received in the through-hole 11 of the base 1. Two ends of the shaft 21 of the rotor 2 are respectively, rotatably received in the support section 12 of the base 1 and the support section 152 of the support element 15. And the permanent ring magnet 23 of the rotor 2 is located in a position relative to the windings 13 on the base 1. The IC control means 14 detects a change in the polarities of the permanent ring magnet 23 of the rotor 2 and sends a signal to alter the polarities of the magnetic fields created by the windings 13, thereby driving the permanent ring magnet 23 to turn by repulsive forces. When the rotor 2 stops, one of the

1 strong magnetic areas 222 of the north and south poles of the permanent ring  
2 magnet 23 is attracted and thus retained in place by the magnetically  
3 attractive positioning member 17 on the base 1. Thus, the strong magnetic  
4 area 222 of each magnetic pole of the permanent ring magnet 23 is located  
5 away from a respective winding 13 on the base 1. Namely, the transition areas  
6 221 of the permanent ring magnet 23 are not proximal to and thus not face the  
7 IC control means 14. As a result, when the rotor 2 is to be restarted, the IC  
8 control means 14 will surely be able to detect the polarities of the permanent  
9 ring magnet 23 and thus reliably restart the motor easily.

10 Fig. 3 illustrates a second embodiment of the invention comprising a  
11 base 3 and a rotor 4.

12 The base 3 is a casing having a through-hole 31. A support section 32  
13 is provided in an end of the through-hole 31. The support section 32 may be  
14 a bearing or shaft sleeve for rotatably holding a shaft 41 of the rotor 4. Even-  
15 numbered windings 33 are securely mounted to an outer wall of the base 3 or  
16 an inner wall defining the through-hole 31. An IC control means 34  
17 comprising a conventional drive circuit and a Hall element is mounted on the  
18 base 3. The IC control means 34 is located between two adjacent windings 33  
19 and electrically connected to the windings 33. In order to allow stable rotation  
20 of the rotor 4, a support element 35 is mounted on the other end of the base  
21 3 and has a support section 351 in the form of a bearing or shaft sleeve. Of  
22 more importance, at least one positioning member 36 made of magnetically  
23 attractive metal is mounted to the base 3. The positioning member 36 can be  
24 of any shape, such as a disc, cube, or plate. The positioning member 36 is  
25 positioned between two windings 33.

26 The shaft 41 of the rotor 4 is rotatably held by the support section 32  
27 of the base 3 and the support section 351 of the support element 35. A  
28 permanent ring magnet 42 is mounted to the shaft 41 of the rotor 4 and  
29 comprises north and south poles. If necessary, a washer 43 made of abrasion-

1 resistant material may be mounted around the shaft 41 and located between  
2 the permanent ring magnet 42 and the support section 32 of the base 3, and  
3 another washer 43 made of abrasion-resistant material may be mounted  
4 around the shaft 41 and located between the permanent ring magnet 42 and  
5 the support section 351 of the support element 35. The permanent ring magnet  
6 42 comprises at least two transition areas 421, each transition area 421 having  
7 a first end contiguous to a north pole and a second end contiguous to a south  
8 pole. Each of the north and south poles has a strong magnetic area 422 located  
9 in an intermediate position between two transition areas 421.

10 As illustrated in Figs. 4 and 5, the base 3 has even-numbered windings  
11 33 mounted to the outer wall thereof. The rotor 4 is received in the through-  
12 hole 31 of the base 3. Two ends of the shaft 41 of the rotor 4 are respectively,  
13 rotatably received in the support section 32 of the base 3 and the support  
14 section 351 of the support element 35. And the permanent ring magnet 42 of  
15 the rotor 4 is located in a position relative to the windings 33 of the base 3.  
16 The IC control means 34 detects a change in the polarities of the permanent  
17 ring magnet 42 of the rotor 4 and sends a signal to alter the polarities of the  
18 magnetic fields created by the windings 33, thereby driving the permanent  
19 ring magnet 22 to turn by repulsive forces. When the rotor 4 stops, one of the  
20 strong magnetic areas 422 of the north and south poles of the permanent ring  
21 magnet 42 is attracted and thus retained in place by the magnetically  
22 attractive positioning member 36 on the base 3. Thus, the strong magnetic  
23 area 422 of each magnetic pole of the permanent ring magnet 42 is located  
24 away from a respective winding 33 on the base 3. Namely, the transition areas  
25 421 of the permanent ring magnet 42 are not proximal to and thus not face the  
26 IC control means 34. As a result, when the rotor 4 is to be restarted, the IC  
27 control means 34 will surely be able to detect the polarities of the permanent  
28 ring magnet 42 and thus reliably restart the motor easily.

Fig. 6 illustrates a third embodiment of the invention comprising a base 5 and a rotor 4.

The base 5 is a casing having a through-hole 51. A support section 52 is provided in an end of the through-hole 51. The support section 52 may be a bearing or shaft sleeve for rotatably holding a shaft 41 of the rotor 4. Even-numbered windings 53 are securely mounted to an outer wall of the base 5 or an inner wall defining the through-hole 51. An IC control means 54 comprising a conventional drive circuit and a Hall element is mounted on the base 5. The IC control means 54 is located between two adjacent windings 53 on the base 5 and electrically connected to the windings 53. In order to allow stable rotation of the rotor 4, at least one rib 57 is formed on the outer wall of the base 5 to prevent damage to the windings 53 or the IC control means 54 when a casing 56 is tightly fitted around the base 5. The casing 56 mounted around the base 5 has an end beyond the base 5, and a support element 55 is mounted to the end of the casing 56. The support element 55 has a support section 551 in the form of a bearing or shaft sleeve. At least one positioning member 561 made of magnetically attractive metal is provided on the casing 56 and can be of any shape, such as a disc, cube, or plate. The positioning member 561 is positioned between two windings 53. In a preferred embodiment, the casing 56 is made of magnetically attractive metal, and the positioning member 561 is directly formed on an inner periphery of the casing 56 by means of pressing. Thus, the positioning element 561 is more proximal to the permanent ring magnet 42 of the rotor 4 than the inner periphery of the casing 56 is.

The shaft 41 of the rotor 4 is rotatably held by the support section 52 of the base 5 and the support section 551 of the support element 55. The permanent ring magnet 42 is mounted to the shaft 41 of the rotor 4 and comprises north and south poles. The permanent ring magnet 42 comprises at least two transition areas 421, each transition area 421 having a first end

1 contiguous to a north pole and a second end contiguous to a south pole. Each  
2 of the north and south poles has a strong magnetic area 422 located in an  
3 intermediate position between two transition areas 421.

4 As illustrated in Figs. 7 and 8, the base 5 has even-numbered windings  
5 53 mounted to the outer wall thereof. The rotor 4 is received in the through-  
6 hole 51 of the base 5. Two ends of the shaft 41 of the rotor 4 are respectively,  
7 rotatably received in the support section 52 of the base 5 and the support  
8 section 551 of the support element 55. And the permanent ring magnet 42 of  
9 the rotor 4 is located in a position relative to the windings 53 of the base 5.  
10 The IC control means 54 detects a change in the polarities of the permanent  
11 ring magnet 42 of the rotor 4 and sends a signal to alter the polarities of the  
12 magnetic fields created by the windings 53, thereby driving the permanent  
13 ring magnet 42 to turn by repulsive forces. When the rotor 4 stops, one of the  
14 strong magnetic areas 422 of the north and south poles of the permanent ring  
15 magnet 42 is attracted and thus retained in place by the magnetically  
16 attractive positioning member 561 on the casing 56. Thus, the strong  
17 magnetic area 422 of each magnetic pole of the permanent ring magnet 42 is  
18 located away from a respective winding 53 on the base 5. Namely, the  
19 transition areas 421 of the permanent ring magnet 42 are not proximal to and  
20 thus not face the IC control means 54. As a result, when the rotor 4 is to be  
21 restarted, the IC control means 54 will surely be able to detect the polarities  
22 of the permanent ring magnet 42 and thus reliably restart the motor easily.

23 The easy-to-start D.C. brushless motor structure in accordance with the  
24 present invention provides a magnetically attractive positioning member  
25 between any two of the windings as well as an IC control means that is  
26 capable of detecting the polarities of the permanent ring magnet of the rotor,  
27 such that when the rotor stops, one of the strong magnetic areas of the  
28 permanent ring magnet of the rotor is attracted by the magnetically attractive  
29 positioning member and thus retained in a place not facing the IC control



1 means. Thus, it is impossible for the transition areas of the permanent ring  
2 magnet to be located in a position proximal to the IC control means. As a  
3 result, when restarting is required, the IC control means will always be  
4 capable of detecting the polarities of the permanent ring magnet of the rotor  
5 and thus allow the rotor to be restarted easily.

6 Although the invention has been explained in relation to its preferred  
7 embodiment as mentioned above, it is to be understood that many other  
8 possible modifications and variations can be made without departing from the  
9 scope of the invention. It is, therefore, contemplated that the appended claims  
10 will cover such modifications and variations that fall within the true scope of  
11 the invention.  
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